Muon Cooling Ring Lattices with Dipoles and Quadrupoles

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This summer we have been following a strategy to improve performance by designing and investigating rings with greater simplicity, compactness and lower beta function values.

In previous designs, which contained a dipole and several quadupoles in each half of the symmetric cell, progress was difficult due to the large space between the magnets.

Chasman-Green Lattice

The first step was to reduce the number of quadupoles between the dipole and the absorber from 2 to 1, that is from a QD. QF doublet to a QF singlet. The vertical focusing of the QD was taken up by focusing from a gradient in the dipole.

The next step was likewise to reduce the number of quadupoles between the dipole and the rf cavities from 2 to 1.

These changes resulted in a cell lattice similar to a Chasman-Green light source lattice, with two major differences: the central QF of the light source is split in two with a lowbeta point for the absorber between, and the focusing of the dipole is enhanced by giving it a gradient.

The result of these changes is the first lattice we will discuss today, which dates from last June. However, the gradient dipole is replaced by a 0 gradient dipole bordered by two thin quadrupoles. Parameters of this lattice are shown in the first column of the following table. Compared to rings of about a year ago the changes are very substantial: the circumference is reduced from about 80 to 32 meters, the peak betas from 11 to 5 meters.

Dipole only Lattice

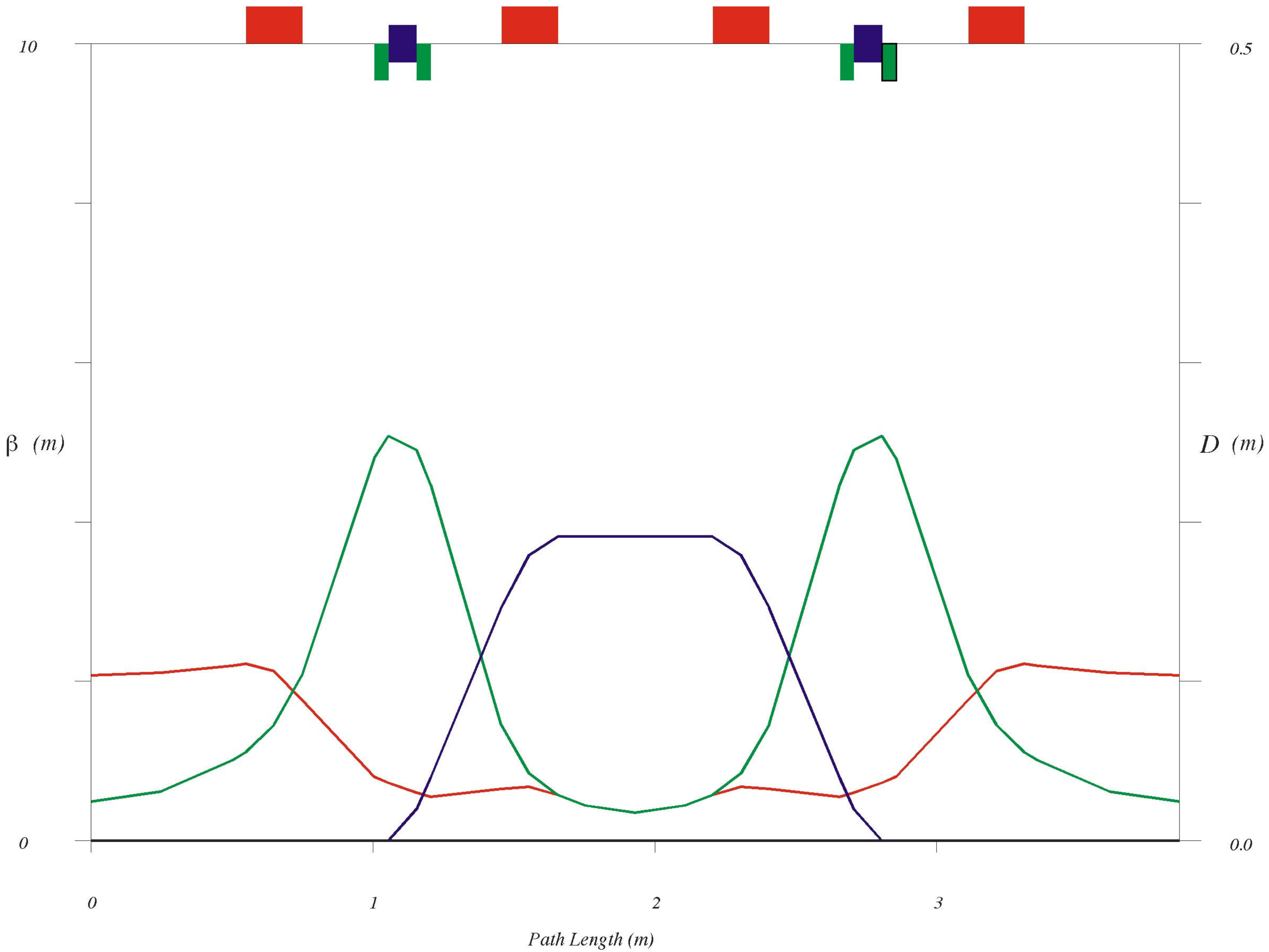
To make further progress we explored replacing quadrupole focusing with that from the edges of dipoles having an angle with the beamline entering or leaving the dipole. A single dipole can thus function as a focusing triplet from the two edges and the horizontal focusing from the body of the magnet.

In a sequence of lattices we replaced the QF next to the absorber with another dipole, eliminated the QD next to the rf, and finally eliminated one of the dipoles. The result is the dipole only lattice shown in the second column of the table.

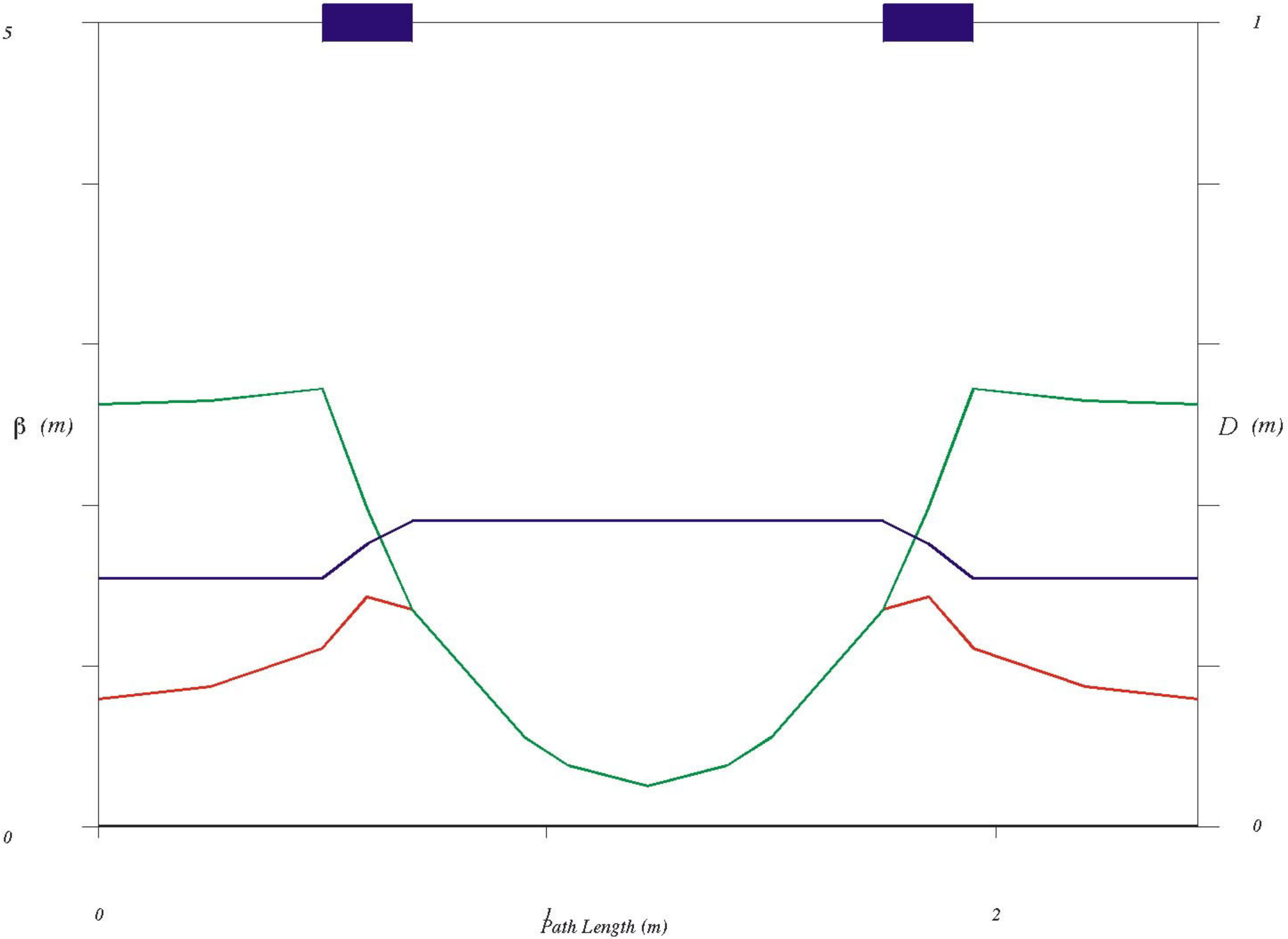
TWO MUON COOLING RING LATTICES

Al Garren, Sept. 17, 2002

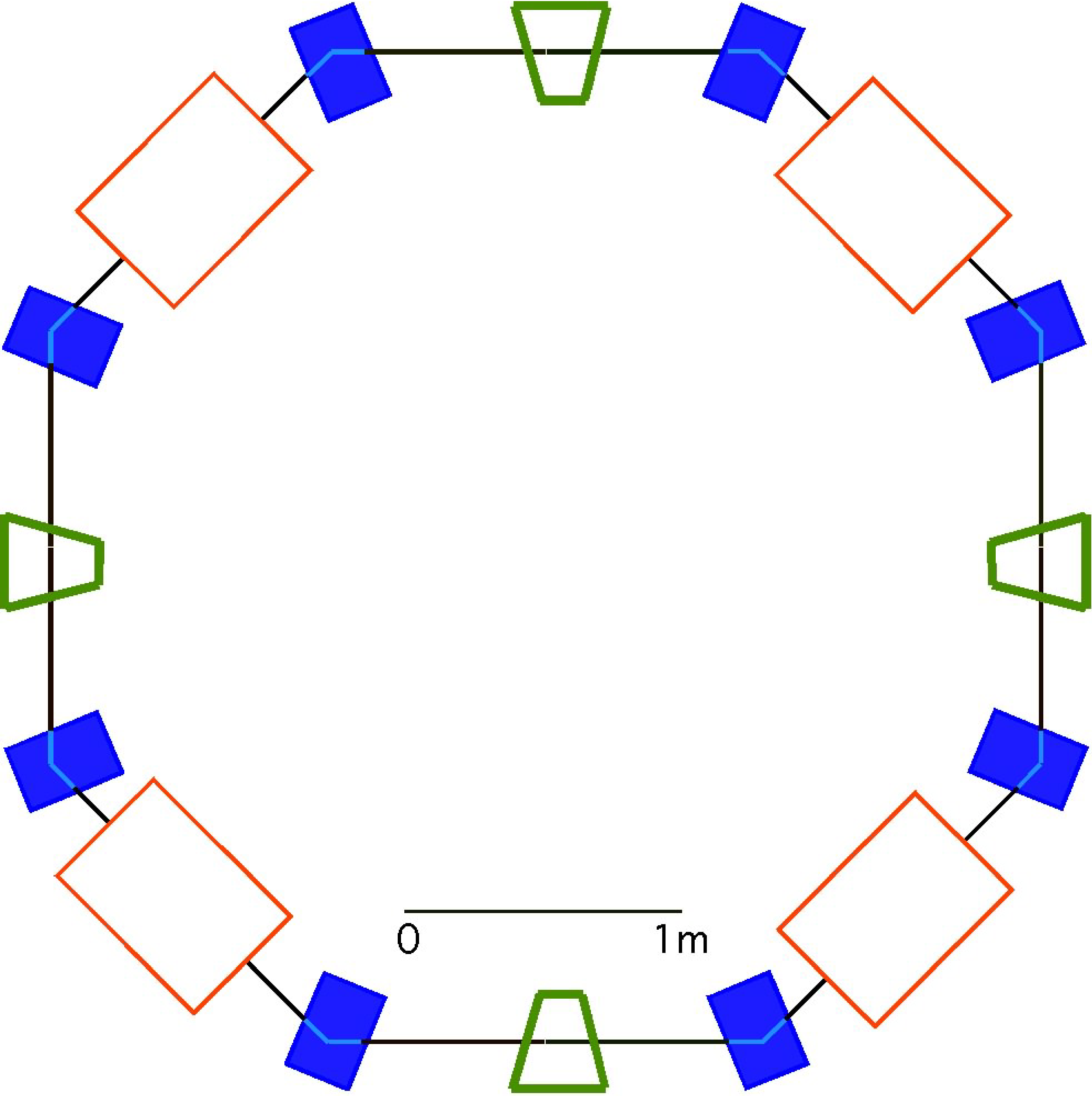
	Chasman-Green	Dipole	
Structure of half cell	'QBQ' dipole + 2 quads	Dipole with edges	
Number Cells	8	4	
Momentum	250	500	GeV/c
Brho	0.8339	1.6678	T-m
Circumference	32.04	9.79	m
Cell length	4	2.45	m
Dipole length	0.2	0.2	m
Quadrupole length	0.2		m
Inter-magnet drift space length	0.25		m
RF and absorber drift lengths	1.10/0.55	1.00/1.05	
Dipole bend angle	22.5	45	deg
Dipole edge angles	0	-7.4/21.8	deg
Dipole radius of curvature	0.5092	0.2546	
Dipole magnetic field	3.275	6.55	T
Quadrupole gradient maximum	20.3		T/m
Cell tunes	.726/.672	.585/.452	
Ring tunes	5.81/5.38	2.38/1.81	
Beta minimum	0.35	0.25	
Beta maxima	2.22/5.08	1.43/2.72	m
Dispersion maximum	0.191	0.38	m
Cell Chromaticities	-0.58, -2.82	-0.42/-0.42	
Momentum compaction	0.00132	0.224	
Transition gamma	27.5	2.11	



10
0
β (m)
0.5
0.0
D (m)
0
1
2
3
Path Length (m)



5
0
β (m)
1
0
D (m)
0
1
2
Path Length (m)



Ten meter dipole cooling ring